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Evaluation of Crestal Bone Loss Around Dental Implants in Cigarette Smokers

Alam S¹, Balehonnur P², Joshi S³, Rahman RA⁴, Thind Gurinder Bir Singh⁵,
Khilji I⁶

¹PhD Student, Oral & Maxillofacial Surgery Unit, School of Dental Sciences, University of Sains Malaysia; ²Department of Prosthodontics, Government Dental College and Research Institute, Bangalore, Karnataka, India; ³BDS, Junior Resident, Department of Dentistry, Gian Sagar Medical College and Hospital, Rajpura, Patiala, Punjab, India; ⁴Oral & Maxillofacial Surgery Unit, School of Dental Sciences, University of Sains Malaysia; ⁵Reader, Department of Oral & Maxillofacial Surgery, MM College of Dental Sciences & Research, Mullana, Ambala, India; ⁶BDS, Medical Officer (Dental), Hazrat Haleema Maternity and General Hospital, Garewal Chowk, Malerkotla, Punjab, India.

ABSTRACT

Introduction: The success of dental implants depends on numerous factors. The harmful effects of smoking on wound healing after tooth extraction are well documented. Cigarette smoke mainly contains nicotine that delays bone healing and affects the survival of the implant.

Objectives: This study was done to assess the marginal bone loss around dental implants in smokers and nonsmokers.

Methods: The study included 100 individuals who received dental implants in maxillary or mandibular edentulous regions from 2015 to 2019. The sample was divided into two groups: Group A (smokers, n = 50) and Group B (nonsmokers, n = 50). Marginal bone loss was measured on the distal, mesial, buccal, and lingual side of each implant after 3, 6 and 12 months using periapical radiographs.

Results: The crestal bone loss around dental implants was significantly higher in smokers (Group A) as compared to nonsmokers (Group B) regardless of the period of loading ($P < 0.001$).

Conclusion: Smoking overall lowers the success rate of dental implants. With increased duration and frequency of smoking, a higher degree of marginal bone loss around dental implants can occur.

Key Words: Dental implants, Marginal bone loss, Smoking

INTRODUCTION

The long term dental implants depend on the conservation of the bony support around the implant. Osteointegration or osseointegration denotes a direct bone-to-metal interface without the interposition of nonbone tissue. This perception has been defined by Branemark, as containing a highly differentiated tissue making a direct structural and functional connection between ordered, living bone and the surface of a load-carrying implant.¹ Over his early comments on osseointegration, Branemark revealed that titanium implants could become undyingly incorporated within the bone.² Bone healing around implants contains a cascade of extracellular and cellular biological proceedings that take place at the bone-implant boundary till the implant surface appears finally enclosed with a recently formed bone.³ These biological proceedings comprise of activation of osteogenetic processes

comparable to those of the bone healing process, at least in terms of initial host response.^{4,5}

Early connections of blood cells with the implant affect clot formation. Platelets undergo morphological and biochemical changes. The formed fibrin matrix acts as a scaffold (osteoconduction) for the migration of osteogenic cells and ultimate differentiation (osteinduction) of these cells in the healing section. Osteogenic cells form osteoid tissue and new trabecular bone that ultimately remodels into the lamellar bone in direct contact with most of the implant surface (osseointegration).^{6,7} Matrix is an early-formed calcified fibrillar layer on the implant surface, relating poorly mineralized osteoid similar to the bone cement lines and laminae limitans that forms a continuous, 0.5 mm thick layer that is rich in calcium, phosphorus, osteopontin, and bone sialoprotein.⁸

Corresponding Author:

Dr. Sarwar Alam, PhD Student, Oral & Maxillofacial Surgery Unit, School of Dental Sciences, University of Sains Malaysia.
E-mail: sarwaralam@rediffmail.com

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In the oral cavity, the smoking habit is related to delayed bone healing, decreased bone height, increased bone loss rate, poor quality bone formation and increased incidence of peri-implants.⁹ Smokers present 1.69 times higher chances of implant failures than nonsmokers during the first implant surgical stage (before prosthesis insertion). Furthermore, a multivariate survival examination displayed that implant placement in the maxilla and short implants were risk factors for failure of the implant.¹⁰⁻¹²

Generally, implant failure is defined as the mobility of the implant during osseointegration or postoperative loading.¹³ The success rate of implant based on several factors consisting of; operator skill, oral hygiene, implant material used, bone quality and quantity, occlusal load, absence of medical conditions, and personal oral habit such as smoking.^{14,15}

This prospective study was done to evaluate the smoking effect on the dental implant survival rate.

MATERIALS AND METHODS

The present study was conducted on 100 patients (68 men, 32 women) within an age group of 30–55 years who received 160 dental implants between 2015 and 2019. All these patients were divided into two study groups, Group A (smokers, $n = 50$) and Group B (nonsmokers, $n = 50$) and the detailed smoking history (type, number of cigarettes smoked per day and duration) was noted on a self-assessment questionnaire.

The inclusion criteria were; patients with or without a history of smoking, with periodontal healthy teeth adjacent to the implant site and without any periapical lesion. The exclusion criteria were; inadequate bone volume, history of local or systemic disease, pregnancy or breastfeeding, longterm oral medications, and nontreated periodontal disease.

Detailed information of each participant about implant characteristics such as implant location, type, implanted jaw, and bone quality was attained. The location of implant placement was either classified into the anterior or posterior region and maxillary or mandibular area. Ethical approval was attained from the institutional review board. Informed consent was taken from all participants. Patients were recalled at 3, 6 and 9 months for evaluation of implant success.

The smoking effect on the success of the implant was recognized by measuring the bone loss around the distal, mesial, lingual and buccal side of each implant using periapical radiographs. On the radiographic images, the distance from the widest part of the implant to the crestal bone level was calculated. Marginal bone attachment at the buccal, lingual, mesial and distal, portions of all implants was visually evaluated, the mean of their measurements was deliberated, and the difference in marginal bone over time was noted as the

MBL (mesial buccal lingual) of each implant.

The obtained data were evaluated statistically using the Statistical Package for Scientific Studies for Windows (SPSS) version 21, IBM, Armonk, NY, USA, using “Paired *t*-test” at a significance level of $P \leq 0.05$.

RESULTS

Table 1 shows marginal bone loss around dental implants in Group A (smoker) patients. The mean marginal bone loss around Group A dental implants 3 months after loading was 2.2 ± 0.13 mm in the maxillary anterior region, 2.4 ± 0.18 mm in the maxillary posterior region, 2.6 ± 0.14 mm in the mandibular anterior region, and 2.9 ± 0.19 mm in the mandibular posterior region, 6 months after loading was 2.6 ± 0.18 mm in the maxillary anterior region, 2.7 ± 0.23 mm in the maxillary posterior region, 2.7 ± 0.21 mm in the mandibular anterior region, and 2.8 ± 0.24 mm in the mandibular posterior region, and 9 months after loading was 3.2 ± 0.34 mm in the maxillary anterior region, 3.5 ± 0.46 mm in the maxillary posterior region, 3.6 ± 0.25 mm in the mandibular anterior region, and 3.8 ± 0.53 mm in the mandibular posterior region. Figure 1 indicates, a diagrammatic representation of marginal bone loss around the implant in smokers at 6, 9 months.

Table 2 shows marginal bone loss around dental implants in Group B (nonsmoker) patients. The mean marginal bone loss around Group B dental implants 3 months after loading was 1 ± 0.28 mm in the maxillary anterior region, 1.2 ± 0.28 mm in the maxillary posterior region, 1.4 ± 0.37 mm in the mandibular anterior region, and 1.6 ± 0.40 mm in the mandibular posterior region, 6 months after loading was 1.4 ± 0.56 mm in the maxillary anterior region, 1.4 ± 0.39 mm in the maxillary posterior region, 1.8 ± 0.37 mm in the mandibular anterior region, and 1.9 ± 0.42 mm in the mandibular posterior region, 9 months after loading was 1.5 ± 0.65 mm in the maxillary anterior region, 1.9 ± 0.52 mm in the maxillary posterior region, 2.0 ± 0.56 mm in the mandibular anterior region, and 2.2 ± 0.48 mm in the mandibular posterior region.

Marginal bone loss around dental implants was significantly higher in smokers (Group A) as compared to nonsmokers (Group B) regardless of the period of loading ($P < 0.001$). With increased frequency and duration of cigarette smoking habit, there was a higher implant failure rate and mobility among smokers as compared to nonsmokers and it was statistically significant (Table 3).

DISCUSSION

Cigarette smoking may harmfully affect wound healing and thus, threaten the success of bone grafting and dental implantation. Heat and the toxic by-products of cigarette smoking

can impair healing, and, therefore, may affect the success and survival of the dental implant.

Yang et al. has done a study to assess the alterations in the characteristics of titanium surface and the osteoblast-titanium interactions under cigarette smoke extract (CSE) exposure. Titanium samples were submerged in CSE to explore the changes in the characteristics of the titanium surface. They found that the adsorbed carbon-containing compounds were the chief reason for smoking-mediated inhibition of the osseointegration.¹⁶

Baig and Rajan¹⁷ in their study suggested significantly more marginal bone loss following implant placement and an increase in the incidence of peri-implantitis. Bain and Moy¹⁸ suggest that long periods of abstinence are required. Yet, the mechanism in which the tobacco affects the osseointegration and the survival of implants remains unidentified. Implant failure commonly found due to the deposition of fibrous tissue at the bone-implant interface.^{9,12}

The cigarette has more than four thousand bioactive chemical components with potential deleterious effect on human tissues including bone.¹⁹ The aldehydes, nitrosamines, carbon monoxide, ammonia, carbon dioxide, and benzene are constituents of the cigarette that may disturb the bone healing process. Carbon monoxide is a competitor/inhibitor of the oxygen and reduces the oxygen-carrying capability of red blood cells; the hydrogen cyanide encourages hypoxia by hindering the enzyme systems essential for metabolism oxidation. Besides, smoking is related to an increased concentration of reactive oxygen and decreased levels of vitamins. The earlier studies have associated high levels of reactive oxygen with the bone resorption process which may clarify the negative outcome of smoking on the osseointegration process.¹⁹

Furthermore, nicotine decreases osteoblastic activity disturbing the amount of collagen available to form the extracellular matrix. Nicotine may encourage microvascular obstruction which results in ischemia and reduces the blood cells.²⁰ Nicotine also decreases the proliferation of macrophages.^{11,12} Feiloutzis et al.²¹ described that heavy smokers (>20 cigarettes per day) confirmed a suggestively increased marginal bone loss (mean = 1.98 mm) ($P < 0.01$) around the implants when associated with nonsmokers (0.18 mm) and patients who stopped smoking (mean = 0.24 mm).

Kan et al.²² used a cumulative success rate (CSR) analysis and reported that nonsmokers had a significantly higher implant success rate (82.7%) when compared to smokers (65.3%) ($P = 0.027$). The risk of failure in smokers was described to be twice higher than in nonsmokers; however, these researchers failed to prove the smoking effect as being dose-dependent.

Lindquist et al.²³ described significantly higher marginal

bone loss around implants in heavy smokers of more than >14 cigarettes per day compared to those with low cigarette consumption of lesser than <14 cigarettes per day.

In our study, the success of the implant was noticeably higher in nonsmokers compared to smokers. Implant mobility and the failure rate was found to be expressively greater in individuals who smoked > 20 cigarettes/day over 10 years.

Comparable results were assessed by Fartash et al.²⁴ in a study on mandibular implant overdentures. Hamad assessed the smoking effect on the bone around the dental implant and concluded that Smoking could be a factor results in future implant failure.²⁵ Chrcanovic et al, evaluated the smoking effect on failure rates, postoperative infection and marginal bone loss of dental implants and concluded that smoking can influence implant failure similar to our findings.²⁶ Takamiya et al. and observed higher implant failures with a smoking habit similar to our findings.²⁷

The success of implant was noticeably higher in nonsmokers compared to smokers. Additionally, the failure rate of implant increased with the frequency and duration of cigarette smoking habit but was statistically not significant. Further, longer-term studies are needed on larger samples size.

CONCLUSION

The present study indicated that increased frequency and long duration of smoking habit were associated with decreased implant survival rate compared to nonsmokers.

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Authors contribution

1. SA- Investigation, Data analysis
2. PB- Editing
3. SJ- Analysis
4. RAR- Data analysis
5. GBST - Manuscript writing
6. IK- Editing

REFERENCES

1. Branemark PI. Vital microscopy of bone marrow in the rabbit. Scand J Clin Lab Invest 1959;11:1-82
2. Brånemark PI. Osseointegration and its experimental studies. J Prosthet Dent 1983;50:399-410.
3. Soballe K, Hansen ES, Brockstedt-Rasmussen H, Bünger C. Hydroxyapatite coating converts fibrous tissue to bone around loaded implants. J Bone Joint Surg Br 1993;75:270-278.
4. Soballe K. Hydroxyapatite ceramic coating for bone implant fixation. Mechanical and histological studies in dogs. Acta Orthop Scand Suppl 1993;255:1-58.

5. Shroff Y, Shah M, Vyas M, Pandya R. Smoking and implant failure: An evidence-based review. *IOSR J Dent Med Sci*. 2018;17:60-64.
6. Berglundh T, Abrahamsson I, Lang NP, Lindhe J. *De novo* alveolar bone formation adjacent to endosseous implants. *Clin Oral Implants Res*. 2003;14:251-262.
7. Pereira ML, Carvalho JC, Peres F, Fernandes MH. Effect of nicotine in matrix mineralization by human bone marrow and Saos-2 cells cultured on the surface of plasma-sprayed titanium implants. *J Biomed Mater Res* 2009;88:84-93.
8. Meyer U, Joos U, Mythili J, Stamm T, Hohoff A, Fillies T, et al. Ultrastructural characterization of the implant/bone interface of immediately loaded dental implants. *Biomaterials* 2004;25:1959-1967.
9. Sverzut AT, Stabile GA, de Moraes M, Mazzonetto R, Moreira RW. The influence of tobacco on early dental implant failure. *J Oral Maxillofac Surg* 2008;66:1004-1009.
10. Balatsouka D, Gotfredsen K, Lindh CH, Berglundh T. The impact of nicotine on bone healing and osseointegration. *Clin Oral Implants Res*. 2005;16:268-276.
11. Garg A. Pathophysiology of tobacco use and wound healing. *Dent Implantol Update*. 2010;21:1-4.
12. Takamiya AS, Goiato MC, Filho HG. Effect of smoking on the survival of dental implants. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2014;158:650-653.
13. Takamiya AS, Goiato MC, Gennari Filho H. Effect of smoking on the survival of dental implants. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2014;158:650-653.
14. Shenava S, Singh P, Sharath Babu C, Kumar V, Jyoti B, Sharma S. Co-relation between smoking and bone healing around dental implants: A clinical study. *J Int Oral Health* 2016;8:1-3.
15. Arora A, Reddy MM, Mhatre S, Bajaj A, Gopinath PV, Arvind P. Comparative evaluation of effect of smoking on survival of dental implant. *J Int Oral Health* 2017;9:24-27.
16. Yang J, Shao S, Chen W, Chen C, Zhang S, Qiu J. Cigarette smoke extract exposure: Effects on the interactions between titanium surface and osteoblasts. *BioMed Res Int* 2019;5:1-11.
17. Baig MR, Rajan M. Effects of smoking on the outcome of implant treatment: A literature review. *Indian J Dent Res* 2007;18:190-195.
18. Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. *Int J Oral Maxillofac Implants* 1993;8:609-615.
19. Pereira ML, Carvalho JC, Peres F, Gutierrez M, Fernandes MH. Behaviour of human osteoblastic cells cultured on plasma-sprayed titanium implants in the presence of nicotine. *Clin Oral Implants Res*. 2008;19:582-589.
20. Nitzan D, Mamlider A, Levin L, Schwartz-Arad D. Impact of smoking on marginal bone loss. *Int J Oral Maxillofac Implants* 2005;20:605-609.
21. Feloutzis A, Lang NP, Tonetti MS, Burgin W, Bragger U, Buser D, et al. IL-1 gene polymorphism and smoking as risk factors for peri-implant bone loss in a well-maintained population. *Clin Oral Impl Res* 2013;14:10-17.
22. Kan JY, Rungcharassaeng K, Lozada JL, Goodacre CJ. Effects of smoking on implant success in grafted maxillary sinuses. *J Prosthet Dent* 1999;82:307-311.
23. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. *Clin Oral Implants Res* 1996;7:329-336.
24. Fartash B, Tangerud T, Silness J, Arvidson K. Rehabilitation of mandibular edentulism by single crystal sapphire implants and overdentures. 3-12 year results in 86 patients. A dual center international study. *Clin Oral Implants Res* 1996;7:220-229.
25. Hamad TY. Amount of bone loss after maxillary dental implant loading in smoker and non-smoker patients. *J Bagh College Dentistry* 2012;24(1):1-6.
26. Chrcanovic BR, Albrektsson T, Wennerberg A. The impact of smoking on failure rates, postoperative infection and marginal bone loss of dental implants. *Evidence-Based Dentistry* 2016;17:4-5.
27. Takamiya AS, Goiato MC, Filho MG. Effect of smoking on the survival of dental implants. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2014;158(4):650-653.

Table 1: Marginal bone loss around dental implants in Group A (smoker) patients

Site	3 months after loading in mm	6 months after loading in mm	9 months after loading in mm
Maxillary anterior region	2.2±0.13	2.6±0.18	3.2±.34
Maxillary posterior region	2.4±0.18	2.7±0.23	3.5±0.46
Mandibular anterior region	2.6±0.14	2.7±0.21	3.6±0.25
Mandibular posterior region	2.9±0.19	2.8±0.24	3.8±0.53

Table 2: Marginal bone loss around dental implants in Group B (nonsmoker) patients

Site	3 months after loading	6 months after loading	9 months after loading
Maxillary anterior region	1±0.28	1.4±0.56	1.5±0.65
Maxillary posterior region	1.2±0.28	1.4±0.39	1.9±0.52
Mandibular anterior region	1.4±0.37	1.8±0.37	2.0±0.56
Mandibular posterior region	1.6±0.40	1.9±0.42	2.2±0.48

Table 3: Implant mobility in relation to smoking habit

Habit	Variable	Mobility	P
Smoking history	Smokers	18	0.001
	nonsmokers	2	
Number of cigarette/day	<20	5	0.001
	>20	13	
Smoking years	<10	4	0.001
	>10	14

Figure 1: Diagrammatic representation of marginal bone loss around implant in smokers. A. Marginal bone around implant in non smokers, B. Marginal bone around implant at 6 months in smokers, C. Marginal bone around implant at 9 months in smokers.